CentraleSupélec

COGNITIVE RADIO: AN ENABLER FOR DIGITAL MANUFACTURING

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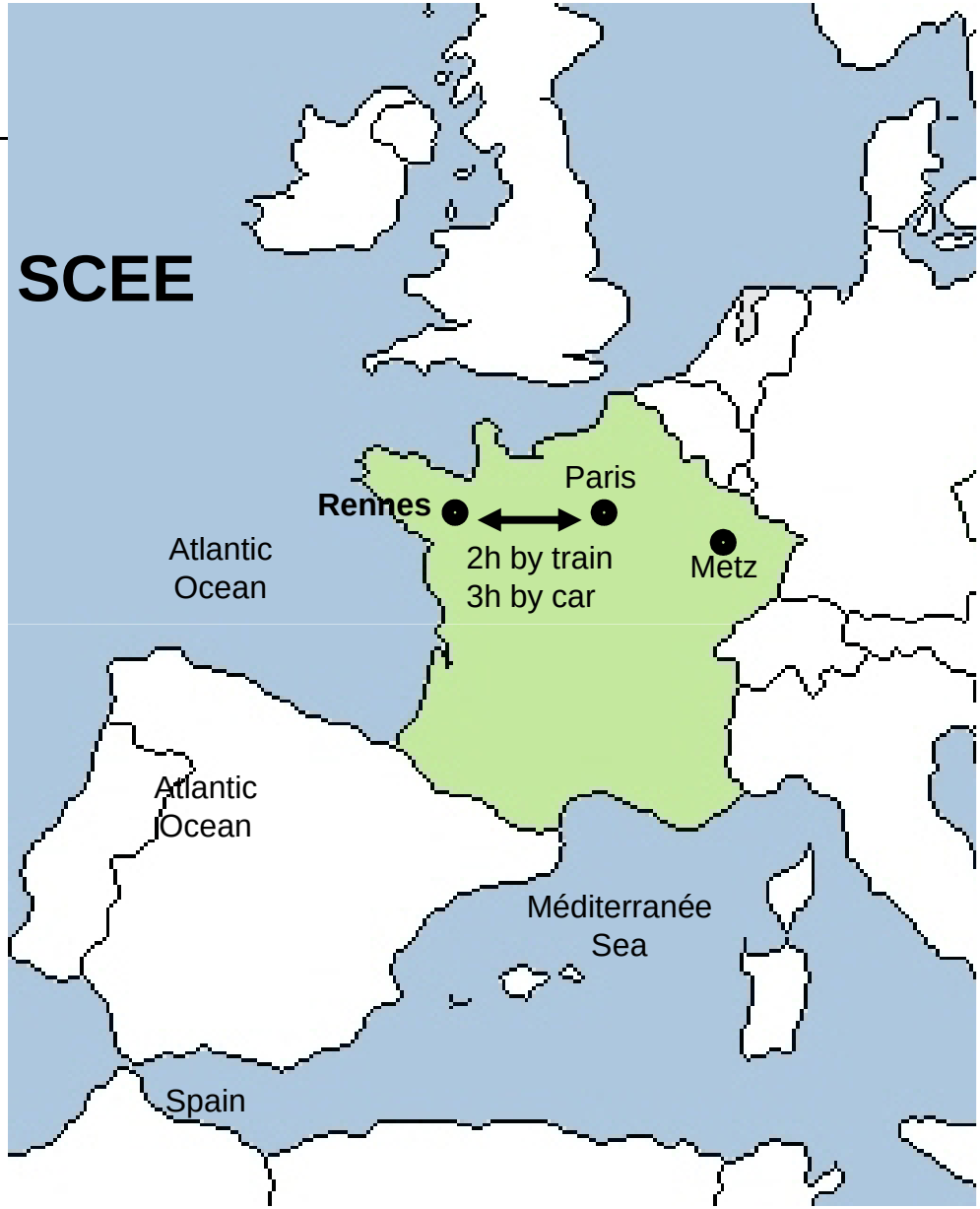
RESEARCH TEAM: SCEE

- Centrale Supélec is currently in 4 campuses
  - Châtenay Malabry (former Ecole Centrale Paris)
  - Gif-sur-Yvette (former Supélec)
  - **Rennes (former Supélec)**
  - Metz (former Supélec)
- Rennes campus
  - **SCEE** reasearch team Signal, Communications and Embedded Electronics
  - Research activities are affiliated to IETR of CNRS (UMR 6164) – Institute of Electronics and Telecommunications of Rennes



RESEARCH TEAM

- SCEE reasearch team
- Signal, Communications and Embedded Electronics
- 10 faculty members
- 15 PhD students / 1-2 post-docs

- International Chair during 2 years (2013-2014)
  - Prof. Honggang ZHANG
  - Zheijang University
  - Green radio communications

RESEARCH TOPICS OF SCEE TEAM

- Digital electronics
  - **Multi-standard radio systems: apply SW principles to radio electronics**
  - **modeling approach of cognitive** electronic **systems**, Model Driven Architecture (MDA), Model Based Design (MBD)
  - FGPA, partial reconfiguration of FPGA, design methodologies for complex HW/SW systems
- Radio-communications
  - Physical layer of wireless communication standards, OFDM, multi-carrier, Filter Bank modulations, synchronisation, PAPR – peak to average power ratio, etc.

➔ Cognitive Radio approach, based on software radio

➔ Towards Green Radio (energy efficiency for wireless communications)

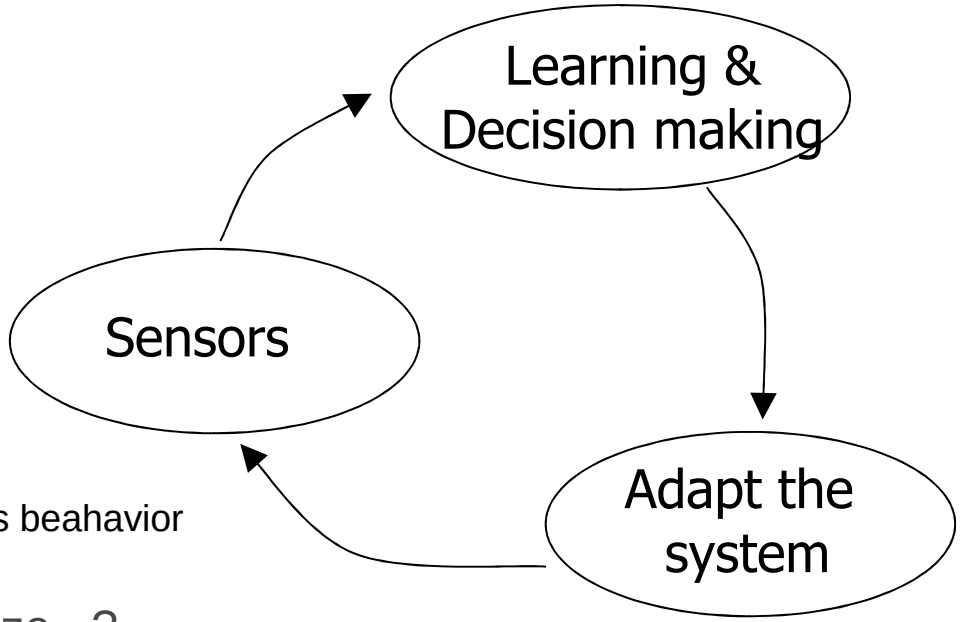
APPLICATION EXAMPLES

- Benefit from cognitive radio in the radio domain
  - **Legacy radio systems, especially in a multi-standard context**
  - Dynamic spectrum allocation to mitigate spectrum scarcity
  - 5G
  - **Sensor Networks**
  - **IoT – Internet of Things**

Benefit from cognitive radio for other domains

- Smart Grids
- Smart Cities
- Intelligent Transport Systems
- **Any Smart System indeed**

COGNITIVE CYCLE



- Cognition requires
  - Sensors
  - Computing means for learning and decision making
  - Adapt the system to optimize its beahavior
- What does it mean « optimize »?
  - Quality / cost / power consumption / etc.
- In our research

➔ making radio systems smarter

➔ also **use wireless systems to make other systems smarter**

TO MAKE A SYSTEM BECOME SMART OR BE SMARTER

• Brain smartness is not only a question of number of neurons

• It is (also/more?) a question of number of connections between neurons

➔**Making a legacy system become smart/intelligent/cognitive means adding communication means between entities**

➔ **wireless communications are easier (mobile, can be added…)**

• Prof. DHANDE this morning: « intercation **Man/Machine/Information**

Digital manufacturing is about **information transfer** between

- sensors and decision center

- decision center and machine »

➔ Digital Manufacturing = « smart manufacturing »

FROM RADIO TO COGNITIVE RADIO – ANALOGY WITH DIGITAL MANUFACTURING (?)

• Radio design has known a completely change of paradigm during these past 40 years

➔ maybe the same change that manufacturing is living today (?)

• Radio design has known a digital revolution

- A lot of processing done by discrete electronic components before
- Haved turned to digital domain
- And when possible to software executed on processors

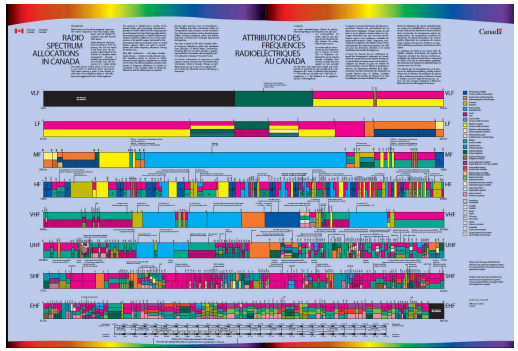
➔ software radio

➔ This opended the door for cognitive radio

- As soon as processing is executed on processor, you can easily **change** it and **turn it intelligent** while adding some artificial intelligence algorithms

➔ maybe the same change for digital manufacturing (?)

COGNITIVE RADIO TO MITIGATE SPECTRUM SCARCITY



- Radio spectrum is overloaded
- There is no more space for new radio applications
- **A new way of using radio spectrum is necessary after 100 years**

- **Dynamic spectrum approaches, based on Cognitive Radio** principles, are studied at rearch level and implemented in stds
  - Research: Opportunistic Spectrum Access (OSA)
    - Application for a better use of current ISM bands
    - Future radio standards
  - Standards: Licence Sharing Access (LSA)
    - ETSI RRS – I am participating to this standardization group which is the most pionneering standardization group in cognitive radio spectrum management worldwide
    - US is trying to fill the gap with ETSI RRS (PCAST)

OPEN TO COOPERATION

- Radio domain
  - Software defined radio approach for legacy radio systems: when **several radio standards in the same systems (plane, car, robot, etc.)**
  - Agile spectrum – get connected with most advanced standards in dynamic spectrum techniques (European ETSI RRS standard group)
  - 5G
  - **IoT – Internet of Things**
  - **Sensor Networks**
- Other domains requiring wireless communications: **high level modelling** (model-based design, Model Driven Architecture)
  - Smart Grids
  - Smart Cities
  - Intelligent Transport Systems
  - **Digital manufacturing**

PROJECTS OF THE TEAM CONNECTED TO DIGITAL MANUFACTURING

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•Examples of industrial research

- Orange: **sensor networks** based on cognitive radio

• Examples of current collaborative funded projects

- European and international level
  - PHC (Hubert Currien funding for French-abroad collaboration) with Greece on **Smart Grids**
- French level
  - SoGreen: **Smart Grid to enpower future cognitive communication networks**

CONTACT ME

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